[0147] The above data represents two different loading configurations and concentrations. By placing upper and lower bounds on each color, a range of acceptability is created. In some embodiments, examining the variability in each device **5** and across multiple devices **5** would provide information for setting the bounds.

[0148] A "do not exceed number" or other bright-line test may be used. For example, such a test may be used to initiate other statistical tests, such as the verification of relations, size, color, or other aspects of the security features, alone or in a group.

[0149] Further testing was performed, where detection of four colors (blue, green, yellow and red) were analyzed individually. Various hand-sheets of paper were made with different concentrations of the security particles **1150**. Loadings ranged from less than 2,000 particles per square decimeter to over 6,000 particles per square decimeter. For these tests, the device **5** was mounted on a platform at a fixed height, while the hand sheets were moved between imaging. Results are provided in **FIGS. 16-22**.

[0150] **FIG. 16** depicts a histogram of various hand sheets containing green security particles; and **FIG. 17** depicts a linear fit of green average counts and loading densities. **FIG. 18** depicts a histogram of various hand sheets containing blue security particles; and **FIG. 19** depicts a linear fit of blue average counts and loading densities. **FIG. 20** depicts a histogram of various hand sheets containing yellow security particles; and **FIG. 21** depicts a linear fit of yellow average counts and loading densities. **FIG. 22** depicts a histogram of various hand sheets containing red security particles; and **FIG. 23** depicts a linear fit of red average counts and loading densities.

[0151] Testing was performed to optimize the focus distance to maximize counts without an coincident and excessive drop in flash intensity and brightness of the security particles **1150**. The device **5** was set at various distances from the paper **200** a number of images **404** were collected. **FIG. 24** provides a plot of counts versus distance. The total counts for all colors were divided by the area sampled to give a "density" metric. It was decided that the best fixed-focus distance would be where the counts were highest and the density was still maximized. It was determined that an optimal distance for the fixed-focus was approximately 8 cm for the particular combination of paper **200** and device **5**.

[0152] After setting the fixed-focus to 8 cm, the device **5** was moved to other distances to determine the depth of focus. **FIG. 25** shows that positive detection occurred for a depth of focus of nearly 6 cm and the density peaks appeared at approximately 8 cm (as expected).

[0153] Overprinting the security particles **1150** can make detection more difficult. Below are discussed the various types of overprinting and their respective effects.

[0154] Text overprinting in a standard size font and language structure typically covers about 10% of the surface area on a printed page. Based on empirical data, security particles **1150** that are totally overprinted with black text will not be counted. Particles **1150** that are partially obscured will exhibit reduced detectability. Overall, these effects should reduce counts of the particles **1150** on a printed document **200** by slightly more than the percentage or surface area covered by the text overprinting.

[0155] Overprinting with various colored inks can cause different effects. In various experiments, screen-printing was used to produce between about 10% and about 80% coverage of ink on a paper substrate **200**. Various colors were tested including cyan, magenta, green and yellow. Results varied by the color. Preferably, no more than about 30% coverage is present on a substrate **200**. **FIGS. 26-30** present graphs depicting the effect of overprinting on readout.

[0156] **FIG. 26** depicts readout of GBY security particles without any overprint, on 24 pound paper; **FIG. 27** depicts readout of GBY security particles with 30% overprint of cyan ink, on 24 pound paper; and **FIG. 28** depicts readout of GBY security particles with 30% overprint of magenta ink, on 24 pound paper.

[0157] Cyan, magenta and green overprint interfered little with detection at the default read distance. At 80% overprint, total counts were reduced by about half, but positive reads were still easily achieved. A shrinking in the read depth occurred for greater percentages of overprint. However, yellow overprint substantially interfered with detection of the particles **1150**. At 30% overprint, total counts were reduced to levels below the read threshold.

[0158] **FIG. 29** depicts green and blue particles **8111**, **8110** and respective valid color areas **8705**, **8706** in the GB plane **702** with a 30% yellow overprint. **FIG. 29** shows how the yellow overprint shifts most of the particles **1150** out of their respective valid color areas **8705**, **8706**. Other experimentation revealed that ultra-violet inks can greatly perturb the ability to detect some embodiments of the security particles **1150**.

[0159] Further testing was performed to determine the variability in both the device **5** and the subject paper **200**. In one embodiment, the device **5** was positioned above 24 pound paper **200** containing G, B and Y colored particles **1150**, and operated so as to generate 100 successive images **404**. Neither the device **5** nor the paper **200** was moved during the test. Keeping illumination and geometry constant achieved a good representation of the variability in the device **5**. **FIGS. 30-31** provide graphical illustrations of the time series and a histogram of the data.

[0160] Referring to **FIGS. 30-31**, the average counts and standard deviations for the GBY colors were 30.6, 31.0, 20.1 and 2.0, 2.2, 2.2, respectively. This indicates a typical standard deviation of 2 counts for each color regardless of the count level.

[0161] In a similar evaluation, the device **5** was positioned above 24 pound paper containing GBY particles, and operated so as to generate 1000 successive images **404**. In this test, the paper **200** was moved around in random patterns. An attempt was made to evaluate as much of the paper as possible without shooting off the edge. It is considered that moving the paper and keeping illumination constant achieved a good representation of the combined variability in the device **5** and the paper **200**. **FIGS. 32-33** depicts the data for the time series and a histogram of the data.

[0162] In this test, the average counts and standard deviations for the GBY colors were 29.8, 36.2, 17.8 and 6.0, 5.4, 4.0, respectively. Combining these numbers with the fixed data, it can be seen that the displacements of the particles **1150** in the paper **200** have standard deviations of roughly 4.0, 3.2 and 1.8, respectively, for the GBY colors.